Bulletin No. 17

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Extension Service

Manitoba Agricultural College

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Filling the Stave Silo at the College Barn

Silo Construction and Ensilage Production in Manitoba

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Manitoba Agricultural College,
Winnipeg, Canada,
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To the HON. VALENTINE WINKLER,
Minister of Agriculture and Immigration,
Winnipeg, Manitoba

Sir,—I beg to present herewith Bulletin No. 17 of the Manitoba Agricultural College, entitled "Silo Construction and Ensilage Production in Manitoba," by T. J. Harrison, B.S.A., and J. H. Bridge, B.S.A., of the Field Husbandry Department, and W. J. Gilmore, B.C.E., B.S.A.E., of the Agricultural Engineering Department.

This publication is being issued in response to numerous enquiries for information on this subject. I have no doubt that it will prove of great interest to the farmers of this province.

Yours very truly,

W. J. BLACK,
President.

Silo Construction and Ensilage Production in Manitoba

Ensilage and silage are synonymous terms applied to immature, coarse, succulent fodder preserved in air-tight receptacles called silos. These were originally made by digging pits in the earth and lining them with wood or stone; in recent years, however, specially constructed buildings, usually cylindrical in form and much higher than wide, are becoming more popular. In the preservation of fodder in the silo a certain amount of fermentation must take place. This is checked at the proper stage by the lack of air, so that the ensilage comes out in a juicy condition with a slightly acid flavor that is greatly relished by all classes of live stock.

It is not the purpose of this bulletin to discuss the comparative feeding value of ensilage, as this information can be obtained from the Animal Husbandry Department in a bulletin on the Feeding Value of Ensilage and Roots.

There are a number of farm crops, such as oats, peas, clover and alfalfa, that can be preserved in the silo, but in most districts in Manitoba Indian corn will be pre-eminently the ensilage crop because of its keeping qualities, succulent nature and large yield per acre. The method of producing the [illegible] be discussed in this bulletin, as this information is contained in [illegible] No. 19—Fodder Corn in Manitoba—and may be secured by [illegible] the Agricultural College. In the latter part of the bulletin, [illegible] the making of the ensilage from corn and other forage crops will be discussed.

THE ADVANTAGES OF THE SILO

Succulence

It is quite freely admitted that green pasture is the ideal food for most classes of live stock. There is, however, one objection, it is not available more than a few months in the year. By the use of the silo we are enabled to supply at all times succulent feeds that may, in a large measure, take the place of pasture grass. According to the testimony of good authorities, the influence of well preserved silage on the digestion and general health of animals is very beneficial.

Maximum Preservation of Food Materials

The silo also enables us to preserve a larger quantity of the food materials of the original crop than is possible by any other system of preservation known.

When made into hay the grasses and clovers lose some of the food materials contained therein, both on account of unavoidable losses of leaves and other tender parts and on account of fermentations which take place while the plants are drying out. In the case of Indian corn the losses from the latter source are considerable, owing to the coarse stalks of the plant and the large number of air-cells in the pith of these. Under the best of conditions cured fodder corn will lose at least ten per cent of its food value when cured in stooks, and will in many cases considerably exceed this, particularly where the stooks are left out during the winter.

Economizes Food

In feeding fodder corn the coarse stalks are often not eaten by the animals, while with ensilage properly made all is eaten.

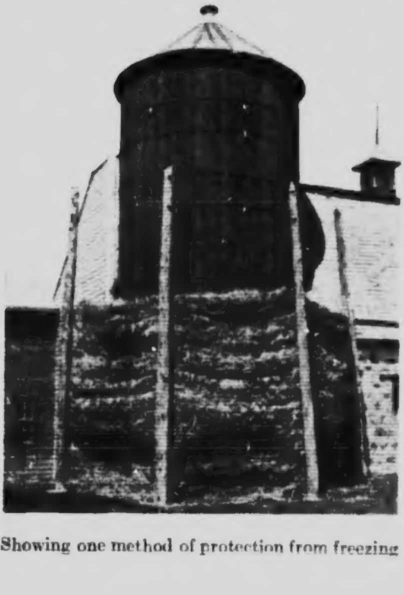
Economy of Storage

The silo also economizes in storage space. It is claimed that an acre of corn, field cured, stored in the most compact manner possible, will occupy a space ten times as great as it will in the form of ensilage.

Avoids Rain Damage

Quite frequently the first crop of alfalfa is ready to cut during the rainy season, and difficulty is experienced in making good hay. Under such conditions the green crop may be stored in the silo.

No Danger of Drouth



Showing one method of protection from freezing

It is a matter of common observation that pastures almost invariably dry up during the late summer months, so that the flow of milk in dairy herds is considerably decreased. Where the first cutting of alfalfa or some other green summer crop has been made into ensilage, it is possible to prevent this sudden loss when the pastures begin to dry up.

Allows of Intensive Farming

Where ensilage is fed it is possible to keep more stock on a given area of land than is otherwise the case. Pasturing is an expensive method of feeding as far as the use of land goes, and can only be practised to advantage where this is cheap. As land increases in value more stock must be kept on the same area in order to correspondingly increase the profits from the land. With the use of the silo the number of animals per acre may be doubled.

THE SILO IN MANITOBA

In the older countries and especially in the dairy districts, the silo is now one of the most important, profitable, and practical adjuncts to the farm. In Manitoba they are past the experimental stage, having proven well adapted to the method of farming and climatic conditions. The farmers who have had most experience with the silo in this province are the most enthusiastic advocates. The first silo erected in Manitoba of which the writer has record was constructed at Brandon in 1891 and filled in 1892. As late as the end of 1912, however, there were but very few. In 1913 and 1914, quite a number were built; so that at the beginning of 1915 there were over fifty in operation. Those in use in this province are largely of wooden stave construction, many of which were purchased from firms selling patent silos shipped ready to erect; others are home-made, and a few are built of concrete.

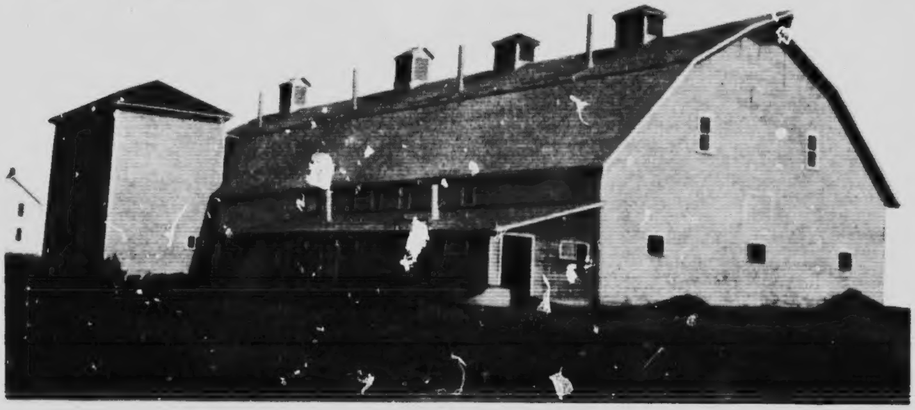
REQUIREMENTS OF THE SILO

The Silo Should be Round

Practically all silos are round, because such a shape renders packing easy; the greatest capacity is obtained for the same amount of material, and the lateral pressure can be taken care of easier.

The Silo Should be Air-tight

The fundamental principle in the preservation of ensilage is the exclusion of air. The silo should be so constructed and maintained that the green feed does not come in contact with the air after filling until it is ready to feed. Rotten ensilage is the result of failure to take this precaution. The greatest danger of loss from this source is around the doors, which frequently do not fit tightly.



An expensive method of preventing freezing

The Silo Should Have Smooth-Faced Walls

Projections on the interior walls, such as inside cleats, protruding foundations, or even a rough wall, hinder the free settling of the mass, with the result that air pockets form, causing spoiled ensilage. (Fig. 1-B illustrates this, showing the lower part of the silo of a smaller diameter than the upper.)

The Silo Walls Must be Rigid and Strong

The outward pressure of the fodder is considerable, especially at the bottom of a high silo, and the walls must be built to withstand this pressure. Then, too, the walls must stand the wind pressure when empty, which is considerable on account of the large surface exposed. In stave silos the iron hoops prevent spreading; in concrete or tile silos reinforcements must be provided. The silo should not be of too great a diameter, as the lateral pressure increases with the diameter.

The Silo Must be High and Narrow

Increasing the height decreases the diameter for the same capacity of silo. This is economical, first because the loss of the spoiled ensilage on the surface is smaller in proportion to the amount stored; second, on account of the increased weight the ensilage will pack better, excluding more air from between the particles, thus reducing the loss from spoiling to a minimum; third, more material is also stored because the cubic foot toward the bottom will contain more pounds of feed than the same at the top. Most silos are built about thirty feet high, but in some cases they are much higher. One disadvantage in building too high is the inconvenience in climbing to the top when feed is required the first few weeks after the silo is opened.

The Size of the Silo

It is difficult to calculate the exact size of a silo for all conditions, as it will depend upon the size of the herd, the amount fed the individual animal, the length of the feeding period, the condition of the corn when placed in the silo, and the method of filling. The height will depend on the feeding period. It should be so arranged that at least two inches can be fed off the surface daily. This is necessary to prevent the ensilage from drying out and moulding. The diameter depends, to a large extent, on the size of the herd, as there should be a sufficient number of animals to lower the contents each day [illegible] required amount. (The size of the silo required may be determined by referring to Table No. 1.) The fourth column refers to the amount after shrinkage occurs, which probably equals ninety per cent of green corn at filling time. On account of the settling it is well to have the silo about five feet higher than column 2 calls for. The amount of this settling will depend on the maturity of the corn and the rapidity of filling.

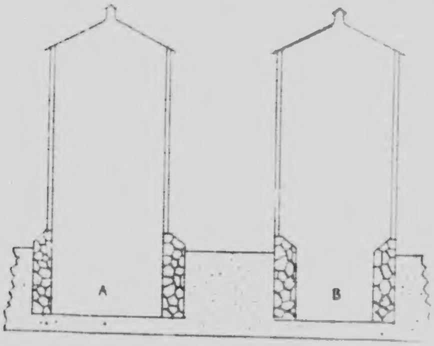


Fig. 1—(A) Shows proper arrangement of staves on foundation. (B) Does not allow ensilage to settle uniformly

Size of Silo

Diameter (inside) in feet	Depth of silo in feet	Capacity in cubic feet	Capacity in tons	Pounds that should be fed daily	Number of animals, 30 lbs. daily	Length of feeding period (days)	Number of animals feeding period 6 months	Acres of corn at ten tons per acre
10	20	1571	30	524	17	120	10	3.5
10	24	1886	37	524	17	144	13	4.0
10	28	2200	44	524	17	168	16	4.5
10	32	2514	51	524	17	192	19	5.5
12	20	2263	45	754	25	120	16	5.0
12	24	2715	54	754	25	144	20	5.5
12	28	3168	64	754	25	168	23	6.5
12	32	3620	78	754	25	192	28	8.0
12	40	4526	110	754	25	240	40	11.0
14	20	3080	60	1028	34	120	21	6.5
14	24	3696	66	1028	34	168	24	7.0
14	32	4928	93	1028	34	192	27	7.5
14	40	6160	140	1028	34	240	50	15.0
16	24	4828	95	1340	45	144	34	10.0
16	32	6436	129	1340	45	192	47	13.5
16	40	8046	179	1340	45	240	65	18.5
18	30	7637	150	1750	59	180	50	16.0
18	36	9164	188	1750	59	216	69	19.0
18	40	10183	230	1750	59	240	84	25.0
18	46	11710	276	1750	59	276	100	28.0

Location of the Silo

Since the ensilage must be fed to the stock at least once a day, the most convenient location is the best. It should be erected close to the barn and connected to the end of the feed-way or feed-room by a feeding chute. This should be closed off as well as possible from the place where the milking is done because, while the feeding of ensilage will not taint the milk in the cow's udder, if there is an odor in the barn it will taint it after it is drawn. In the west there is an advantage in placing the silo inside of the barn, as this reduces the trouble from freezing to a minimum. There is an objection, however, in that it takes up valuable space and is inconvenient to fill. This objection is not so noticeable in a round barn where the silo is located in the centre of the building. Where the silo is located on the outside it is preferable to place it on the south side of the barn to protect it from the north winds and give it the advantage of the sun. This reduces the amount of freezing of the ensilage and prevents decay of the wooden structure. An addition is sometimes built to the barn to enclose the silo, and in this way overcome the difficulty of having it in the barn proper, and will reduce the amount of freezing. (Fig. 2 shows a silo located conveniently to the feed passage.)

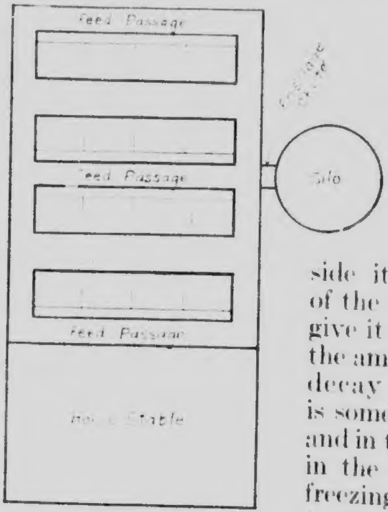


Fig. 2

FIG. 2.—The silo is located for convenience in feeding the ensilage direct from the silo. If the ensilage is to be mixed with other feed it would be better connected with a feed room.

Foundation

The silo, like the other farm buildings, should have a good, substantial foundation. It should be broad enough to prevent settling and sufficiently deep to be not easily disturbed by frost. The weight on the foundation is not great when a wooden superstructure only is considered, but added to this is the weight due to the resistance of the mass settling. Then again at the time of filling, especially if the corn is put in very green, the excess moisture that runs off will have a tendency to soften the footing. Often the space enclosed within the foundation is excavated and made use of for storage. In the case of masonry silos the foundation may continue as the wall, thus eliminating a break at the line where the superstructure rests on the foundation.

Fig. 3

In all forms of wooden silos the foundation should extend one foot above the ground to prevent the decay from dampness. Many of the silos in this province have the bottom on a level with the barn door, but where the ground water does not come near the surface a better plan is to excavate three or four feet and increase the capacity of the silo that much. In the case of an embankment barn it is possible to have much more of the silo under ground, which will facilitate the filling and prevent freezing. It is a good practice where this is done to place a tile drain around the silo to carry off the ground water. Even in connection with an ordinary barn the silo is sometimes put down in the ground. It is not well, however, to go more than five feet below the floor of the stable on account of the work in throwing out the ensilage.

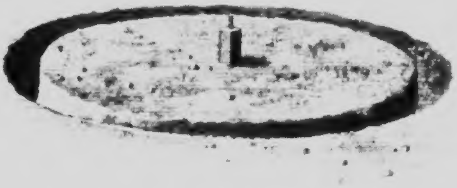


Fig. 4

The cheapest and easiest method of building a concrete foundation is to dig a trench the size of the wall and pour in the concrete. (Figs. 3, 4, 5 illustrate the method of marking, excavating and building the form.) If the trench is widened at the bottom it will provide for footing. When the silo is put down into the ground and the foundation walls used as part of the wall it is sometimes advisable to make the excavation the full size of the silo and use lumber for the inside of the form, utilizing the earth for the outside. In the latter case the lumber should be kept about six inches above the bottom of the excavation. This will allow some concrete to run under the form and make a footing.

The character of the silo must be considered before deciding on the size of footing; for a stave silo a twelve-inch wall with a fourteen to eighteen-inch footing will suffice. The depth of the foundation should be five feet, but in many cases three feet is giving good satisfaction. If stone can be had any cheaper than concrete it can be substituted, as it makes a good wall, providing it is pointed up on the inside with cement.

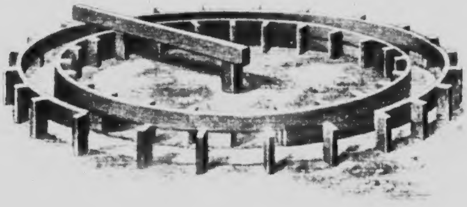


Fig. 5

Bottom of Silo

In some cases where the bottom is dry clay or a firm, non-porous soil, the dirt floor will suffice. It is usually a better practice, however, to put in a concrete floor. A floor about four inches thick made of a mixture of one part of cement to five of gravel will not cost much, and will save a large amount of spoiled ensilage, as the floor will be more nearly water-tight and there will be less loss from the mixing of dirt with the feed. (Fig. No. 6 shows a good method of making a silo floor.)

Materials

Wood, cement, tile, stone and metal are all used in silo construction When properly constructed to give strong, smooth, impervious silos practically all these materials have been used with success. Naturally some are more expensive and are more durable than others. From the standpoint of the preservation of the ensilage, satisfactory results may be obtained from the use of any of them. The wooden and concrete walls are in more general use, and both are giving satisfaction when properly erected.

Wooden Silos

There are many different types of round wooden silos, and a large amount of space could be taken up in describing them, but as the most common is made from staves, only this one will be discussed. The stave silo has been used largely in this province, and has proven quite satisfactory. The success depends largely upon the material used, method of construction and care that is taken after the silo is erected. When the lumber is purchased and the silo erected by the farmer British Columbia fir will usually be the cheapest and best wood to use. It is durable and can be obtained in long pieces, making it unnecessary to splice the staves. Other woods, such as cypress, spruce, tamarac, pine and redwood, are used.

Stave Silos

There are different types of patented stave silos on the market. These are shipped ready to erect. They are chiefly made up of 2x6-inch material, sized, tongued and grooved, and are held together with round iron hoops made of one-half or five-eighth-inch material, depending upon the size of the silo. Each hoop will be in two or three pieces, threaded together by malleable or cast lugs. These permit the tightening of the silo as it dries out during the summer. Home-made silos may be constructed with comparative ease, but are not recommended unless great care is exercised in selecting and erecting the material. The material should be 2 x 6-inch, sized, tongued and grooved, and free from dead knots. To obtain the best results the staves should be the full length of the silo. If the height is so great that it requires splicing a heavy piece of sheet iron may be fitted into saw cuts in the stave ends. (Fig. No. 7 illustrates this method.) The joint should be broken similar to the way carpen-

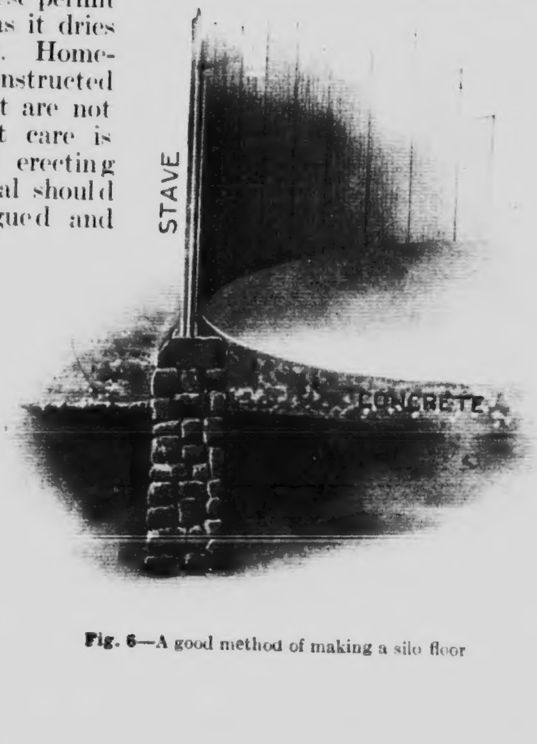


Fig. 6—A good method of making a silo floor

ters break joints in putting on siding. (See Fig No 8.) In erecting the silo considerable scaffolding is sometimes used. (Fig. No 9 shows a cross section of one method of construction.) Before the scaffolding is all in place the staves should be stood up in the enclosure, otherwise, difficulty will be experienced in getting them into position. The first stave set should be made plumb and should be toe-nailed at the top to one of the 4 x 4-inch posts in the scaffolding. Immediately a stave is set in place it should be toe-nailed in place to the preceding stave set. It has been found that the work of setting up and preserving the outline may be materially aided by the use of old barrel staves. (See Fig. No. 10.) For twelve feet in diameter the curve in the stave of a sugar barrel is best adapted; for a sixteen foot silo a flour barrel stave is best, and for a twenty-foot silo the stave of a cement barrel is best. If when the silo staves are put in place they are toe-nailed securely to the ones previously set, and if they are permanently fastened to the upright post in the scaffolding and barrel staves are used as directed above, the silo will have sufficient rigidity to stand until the hoops are put in place. If it becomes necessary for any reason to delay the putting on of the hoops, boards should be nailed across the top of the silo.

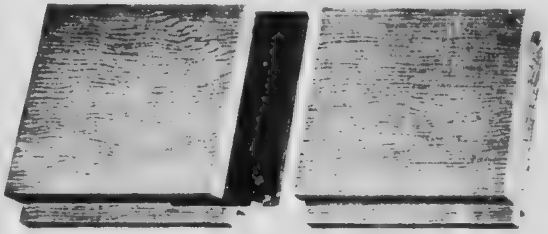


Fig. 7

The home-made silo may be constructed at a saving in cost, and if good material is used and it is well built, it should give good satisfaction. If a carpenter cannot be obtained it would be better to give a contract to a reliable firm. Whether erected by a firm or by a carpenter it would be wise to know that the tongues did not fit too tightly into the grooves, for while in the dried lumber they might seem loose, when it becomes wet they would fit too tightly, and when dry weather comes the shrinking would not be uniform between all the staves, and larger cracks will develop in some places, causing the staves to fall out unless they are kept well tightened during the summer.

Concrete Silos

The concrete silo is coming into quite general favor in many communities. When good materials, well mixed in the right proportions are used, a silo can be made which will compare very favorably with other materials. In general the many failures in the use of concrete about the farm are due mainly to poor workmanship, and it is not recommended that the man without experience with concrete attempt to erect a silo. If he is convinced that he wants a concrete silo it is a better plan for him to either hire an experienced foreman or let a contract under guarantee that a first-class job will be done. The advantages of concrete as a building material for silos are that it is fireproof and durable. If the material is convenient it could be built for a slightly greater cost than the stave silo could be purchased and erected for. Some of the objections made to concrete walls are that they cannot be made impervious to air and water, that the acidity of the ensilage attacks the concrete, causing the walls to become soft and crumbly, cracks develop that cannot be prevented, and that more freezing of ensilage occurs than in the stave silo. From experience with concrete cisterns and other general uses to which concrete is put, its impervious nature cannot be questioned. If the walls are white-washed every year or two with cement the trouble from crumbling will be reduced to a minimum. Cracking of the walls can be largely overcome by using the proper amount of reinforcing. From reports received from owners of stave and concrete silos in Manitoba, the amount of freezing is seen to be as little in concrete as in the wooden stave silos. In using concrete care should be given to the selection of the materials and the proportioning of the sand, gravel or crushed stone and cement. The sand should be composed of hard material, free from vegetable loam, clay, sticks, and organic matter. Preferably it should be of coarse grain or of graded size with coarse grains predominating. Fine sand requires more cement and more thorough mixing for a given strength. The common requirement of sharpness of grain is not necessary. Sand with rounded grains is likely to contain a smaller percentage of voids, requiring less cement for the same strength. The sand which gives the densest mortar will also give the greatest strength. This requires that the percentage of voids be small and that the sand be generally of coarse grain. In concrete work in general the effect of the size and the cleanness of the sand is so great, that it is often advisable to haul a greater distance.

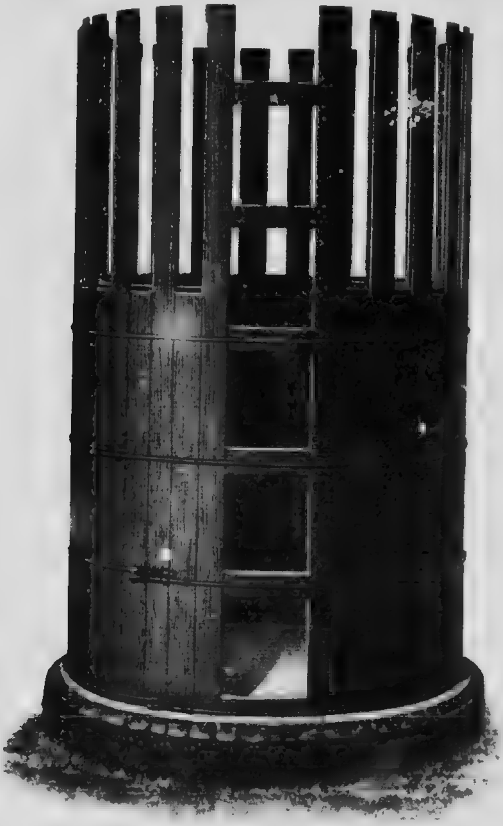


Fig 8.

The size of the gravel should be such that the concrete may be placed in the forms and leave a reasonably smooth finish. To a limited extent the strength of concrete increases with the increase in size of coarse aggregate, hence, the size should not be less than necessary. In the foundation walls large stones may be used satisfactorily. However, it is not good practice to fill the forms with stones and pour in concrete. It is better practice to imbed the stones in concrete and make sure that the stones are not so large that they extend from one side of the wall to the other.

In proportioning concrete the object to be aimed at is to proportion the fine and coarse materials so that the cement may be as effective as possible in filling the remaining voids and binding together the particles of the aggregate. This requires that the percentage of voids be reduced to a minimum, avoiding the use of too much fine material. Often an amount of cement less than sufficient to fill the voids will produce a concrete of ample strength although somewhat porous. This point is well to keep in mind when constructing for water-tightness as in a cistern or silo. Proportioning is commonly done by guess, using certain standard proportions. Better results with greater economy can often be secured by the use of more accurate methods of proportioning as by the determination of voids or by a mechanical analysis. Unless the mechanical analysis of a gravel is known it is always well to pass the material through a quarter inch sieve and remix

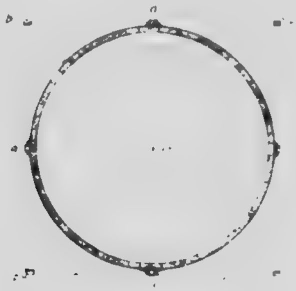


Fig. 9 —Cross section of scaffold (a) 4"x4" or two 2"x4" spiked together (b) 2"x4" held together with pieces nailed to (b) and (a)

A mixture of one part cement, two parts sand and four parts of broken stone or gravel from one-quarter to one and a half inch will make a dense concrete, and is recommended for a solid concrete silo wall. The thickness should be about six inches and properly reinforced. Such a mixture will require about six sacks of cement, 0.45 cubic yard of sand and 0.90 cubic yard of stone for every cubic yard of concrete

Reinforcing

Experiments show that the outward pressure at the bottom of a silo is about eleven pounds for every foot the silo is high. Adding to this the contraction and expansion due to changes of moisture and temperature, it is seen that the pressure is great, and a sufficient amount of reinforcing should be added to assist in carrying this, as the tensile strength of the concrete is not sufficient to rely upon.

Many different shapes of iron and steel are used, such as steel rods, barbed wire and No. 9 wire. The Department of Agricultural Engineering will gladly advise the amounts to use, should information be desired.

Cement Stave Silo

Concrete staves or slabs ten inches wide, thirty inches long and two and a half inches thick are used to some extent for silo construction. They are built with curved interlocking edges, and are placed into a wall and bound together with hoops on the outside to form a wall two and a half inches

Fig. 10 Illustrating method of using barrel staves in erecting staves

Cement Stave Silos, on Glenlea Stock Farm

thick. There is not a great deal of material used in such a silo and after the slabs are made they are erected, much the same as wooden staves are put up. The joints are broken and a hoop placed every fifteen inches vertically. There are no forms to use to erect the silo, no reinforcing required, no danger of cracking due to contraction and expansion of the material, and no hoops to tighten after once the silo is erected. With a good quality of staves and a cement gravy wash on the inside, this silo is a success.

There are two such silos on the Glenlea Stock Farm. An examination of one showed that it was impervious and in good condition after two years' use. The other showed that the juices leaked at the joints, as a result of not applying a cement wash on the inside. The blocks for these silos were made in Minneapolis and shipped to the farm, and the cost was slightly higher than what the same size wood stave silos would cost. In a locality where good material could be obtained close at hand, the cost of a cement stave silo should not be more than that of a good wood stave silo, if the slabs were made on the farm.

Although the walls of these silos were only two and a half inches of concrete, the owner reports as little freezing at the edges as was reported for wooden stave silos.

Vitrified Tile

During recent years vitrified clay blocks have been used quite extensively for building purposes. The Agricultural Engineering Department of Iowa State College has quite recently designed a silo using this material. In this silo building blocks are laid in cement mortar (one part cement, one-third part lime, and two to three parts sand). A sufficient amount of wire to carry the lateral pressure is laid in the walls, and the inside is plastered or washed with cement. Such blocks are easily handled and give the advantages of a double wall with dead air spaces. A silo of this material is quite simple in construction, durable and efficient. The cost of the silo will come higher than one of wooden staves, but is fire-proof and more durable

Doors

Doors are provided for the removal of the ensilage. These should be large enough to easily admit a man, and sufficiently tight to exclude air when the pressure of the ensilage comes against them. Doors are of two types, namely, continuous, which are only obstructed by hoops or bars extending from side to side, and separate doors of larger size, placed at intervals above one another. Continuous doors are in very general use in wooden silos, and separate doors in masonry or concrete silos. In the latter case the vertical break in the wall is eliminated and for this reason even in stave silos would seem to be preferable. In some cases doors are arranged spirally around the silo, but these are not practicable where the feed chute is used. Plans should be made for the doors at the time the staves are set. When the place is reached where it is desired to have the doors a saw should be started in the edge of the stave at the point where the top and bottom of the doors are to come. The saw should be inserted so that the door could be sawed out on a bevel, making the opening larger on the inside of the silo. (Fig. No. 11 gives an idea how the door should be cut.) This will enable the door to be removed and put in place only from the inside, and when in place and the ensilage pressed down, the harder the pressure the tighter will the doors fit. After the silo is set up and the hoops have been put on and tightened, the putting on of the doors may be completed. Before doing this cleats 2x3 inches, in length equal to the width of the door should be made which will conform to the circular shape of the silo. One of these cleats should be securely bolted to the bottom and one to the top of where the door is to be cut. After the bolting the door may be sawed out and it is then ready for use. When set in place at the time of filling the silo a piece of tar paper inserted at the top and bottom will fit the opening made by the saw and prevent the entrance of air around the door. This can be improved upon slightly by having a door jamb on the outside

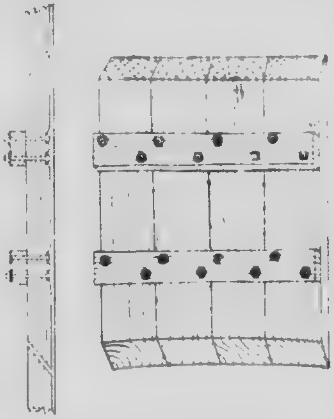


Fig. 11.—Showing one method of cutting out the doors in a stave silo.

Fig. 12

of the door, then bolt on a piece of 2x4 slightly longer than the width of the door. Then when the door is put in place this can be turned around and will catch the ends of the side of the door jamb, pulling the door tightly into place. (Fig. No. 12 shows this method of holding the door in place.) Door frames complete with doors are provided with the silos sold ready to erect. There are many other types of doors, but an attempt will not be made to describe them. It is well to keep in mind that the frame should be rigid and the doors should be close fitting at all times, and so constructed that they can be easily removed and placed in position.

Feeding Chute

Between the barn and silo doors a feeding chute aids in getting the ensilage to the feed room. This may be constructed of inch lumber and 2x4 scantling or metal chute frames may be purchased. At the bottom of each a chute an inclined platform is often placed which shoots the ensilage into the feed room. The ladder erected on the side of the chute or that formed by the top of the door frames enables a man to climb to the top.

Roof

It is just as essential to have a roof for the silo as for any other building. It adds to the appearance, protects and strengthens the silo and makes the same a pleasant place to feed from in the winter. It is more important, however, from the standpoint of the freezing of the surface of the ensilage.

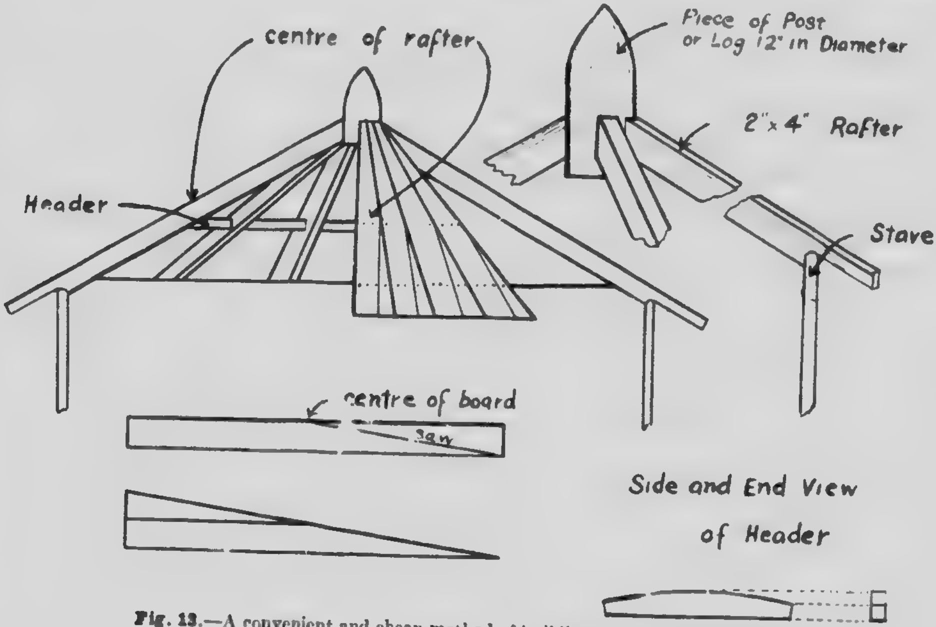
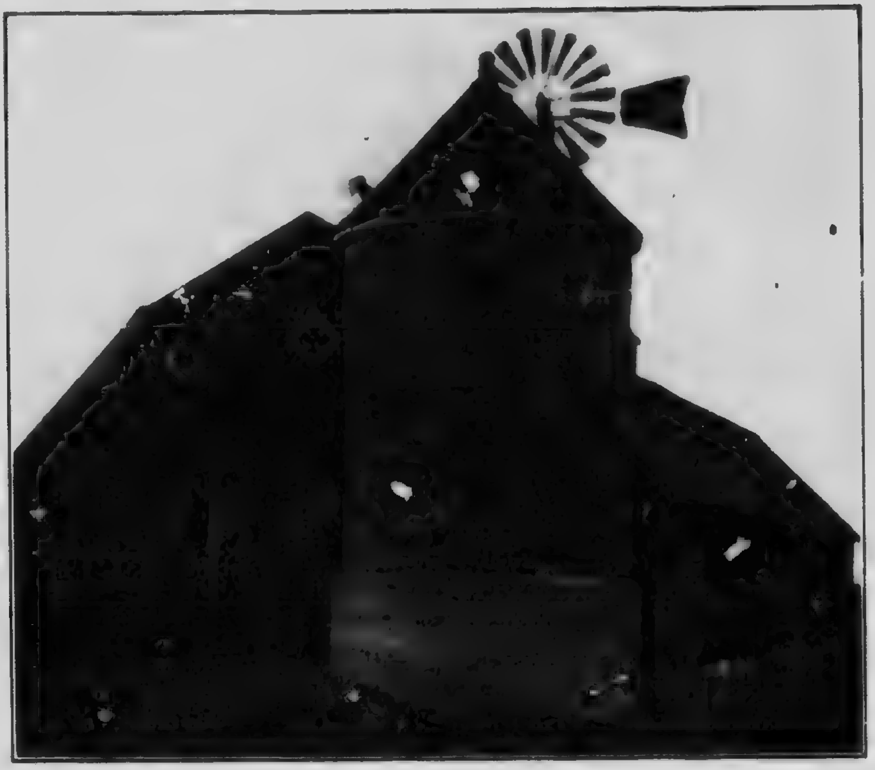

centre of rafter
Piece of Post or Log 12" in Diameter
2"x 4" Rafter
Header
Stave
centre of board
saw
Side and End View of Header

Fig. 13.—A convenient and cheap method of building a roof on a stave silo.



Solid Concrete Silo, built at the end of a bank barn and extending several feet below ground so that the ensilage can be taken out into the stable without being thrown above ground level.

We would not expect a house to be warm in the winter without a roof, no matter how well it was built, and we cannot expect the most favorable conditions in the silo without one. In the roof should be provided a trap door to admit the blower of the cutters, but better still is a dormer window, as it serves for a door at filling time and for light at feeding time. Roofs of most wooden silos sixteen feet or more in diameter consist of a frame work of 2x4 scantling with sheeting. This sheeting may be covered with wooden shingles, galvanized iron or prepared roofing. The latter material is in general use and serves very well, as it gives an almost air-tight roof and is easily put on. (Fig. No. 13 shows the construction and details of one style of roofing.) There are patent roofs on the market which are constructed in sections and can be opened almost vertically. The advantage of such a roof is that it can be raised at filling time and the silo filled considerably above the top of the walls. This allows for the placing of a much larger amount of ensilage in the silo.

Masonry silos may be provided with concrete roofs by using a net work of steel for reinforcement. The roof, if well constructed, will be tight, durable and pleasing in appearance.

Protection Against Freezing

In Manitoba freezing will occur in practically any silo constructed outside of the barn. This is due to loss of heat from the surface and through the silo walls. The freezing from the surface may be reduced by keeping the air above the ensilage from circulating as much as possible. A good tight roof should be provided and the doors should be kept closed as much as possible to prevent the circulation of the air above the ensilage, and keep in the heat generated by the fermentation of the ensilage. In feeding it is important to keep the surface nearly level, if anything, the centre should be kept a little higher than the sides, not digging a hole in the middle of the silo and allowing a ring of frozen ensilage to remain on the outside. With a frozen ring it is found hard to keep it from thickening as feeding continues. In some cases a blanket of canvas is used over the surface, which is raised at feeding. This is found to work very satisfactorily in hindering the circulation of the air and prevent freezing on the surface. Freezing through the silo walls may be reduced by using as nearly a non-conducting material as possible. The stave, stone and concrete walls compare very favorably in this respect. There are no greater variations with these materials than is found in different silos of the same material. Much, no doubt, depends on the condition of the corn at filling time and the location of the silo.

Walls with a dead air space have an advantage in reducing the amount of freezing. The amount of heat or cold which will pass through the wall depends inversely on the amount of circulation through the air space and the amount and kind of material used in connecting the outer and inner walls. Dead air spaces can be readily provided in concrete block or clay tile silos, and for this reason, should be superior to the solid stone or concrete walls. As a further precaution rough boards or poles may be nailed upright, leaving a space surrounding the silo which can be filled with straw or manure in the fall. In the spring this material should be thrown out, giving the walls a chance to dry out, thus preventing their decay.

According to experimental evidence available, the freezing of ensilage should be regarded as an inconvenience rather than as a positive detriment. When the ensilage is thawed out it is eaten with nearly as much relish as that which has not been frozen. It should be fed as soon as possible after being thawed, as it will spoil much quicker than unfrozen ensilage.

Care of Wooden Stave Silos

Precaution must always be taken to keep the silo hoops tight in the summer. If a wooden stave silo is to stand firmly under our conditions it must always have the hoops tight and be anchored to the barn or by guy wires. If the hoops are not kept tight the sides are liable to shrink and collapse inward during a high wind. Neglect to take these precautions may result in the silo blowing over. The actual cost of re-erecting and re-placing broken staves in one silo that blew over in Manitoba was $135. This expense and trouble, no doubt, could have been avoided had a few minutes been given to the tightening of the hoops.

Cost of Silos

Under ordinary conditions in Manitoba the wood silo is the cheapest in first cost, especially is this true if a good grade of sand and gravel cannot be obtained conveniently. If the cost of lumber and labor for making the forms were not considered, there is a question whether, with good material readily available and the work executed by a good workman, the cost of the concrete silo would be higher than the first cost of the wooden stave silo, as in the erecting of it there is less work than in the erecting of a concrete silo. For this reason the former will be used almost exclusively for some years. The cost of a good stave silo will depend on the condition and the size, but will range from $150 up.

ENSILAGE CROPS

Almost any green crop can be made into ensilage if sufficient care is taken to force the air from the material. On account of the difficulty, however, of expelling air from plants with hollow stems, such as grasses and small grain crops, these are rarely put in the silo.

Indian Corn

Wherever ensilage is fed on the American Continent Indian corn is the principal crop used, and it appears likely to become the principal crop in Manitoba. One of the reasons for this is, that ordinarily corn will produce more food material to the acre than any other crop that can be grown. It is more easily harvested and placed in the silo than any of the other forage or cereal crops. Furthermore, corn makes a better quality of ensilage, first, because the stems are solid and less air is incorporated; second, it is less liable to rot than the legumes. Some objection has been raised concerning corn ensilage on the ground that it contains an insufficient amount of protein to provide a balanced ration. This could be overcome by ensiling a legume, such as alfalfa or peas, along with the corn. It is believed, however, that such a procedure is not to be recommended if it is possible to cure the alfalfa or other crop into hay. Some dry forage crop should always be fed with the ensilage, and it is better to use the leguminous crop in this way.

Variety of Plants

The best variety of corn for the silo in any locality is the one which will become reasonably mature before frost. In the early years of the silo it was believed that the variety that would yield the largest amount of green forage per acre was the best to grow. It has been proven, however, by experiments that such is not the case. The feeding value will depend upon the percentage of digestible dry matter in the plant. The following are varieties that may be used successfully in Manitoba for ensilage production: Longfellow, North-western Dent, North Dakota Flint, Gehu and Free Press. The two first named are practically as good as can be had for the southern portion of the province, while the latter would be suitable for the northern sections. A selection of Quebec Yellow, known as Quebec No. 28, gives promise of being a very suitable variety in th[illegible]ties.

Time to Harvest

The best time to harvest corn for ensilage is the time at which it is best harvested for fodder, that is, when the grain has become glazed and the lower leaves have turned brown. It is found that the largest amount of food material is not obtained until the corn is well ripened. Ensilage made from immature corn is not only less nutritious, but also more acid. The corn should not be allowed to become too thoroughly ripe and dry, because the stalk and foliage are rendered more difficult to digest and the corn cannot be packed so tightly in the silo without using excessive quantities of water. Under our conditions a general statement might be made that the corn should be left as long as it is possible to do so and avoid frost. In case the corn is frozen before it is ready to be cut it should be harvested promptly before it has had time to dry out to any great extent. It has been proven, however, that fairly dry corn can be successfully ensiled providing sufficient water is [illegible] to cause the material to be packed tightly in the silo. Under normal conditions in Manitoba it is usually advisable to leave the corn upon the ground for two or three days after cutting in order to get rid of the surplus moisture. If this is not done there will be considerable loss of feeding material in the moisture that runs off through the bottom of the silo and around the doors. It has been suggested that this loss might be largely avoided by placing several feet of cut straw in the bottom of the silo before filling.

ENSILAGE CROPS OTHER THAN CORN

Besides Indian corn there are other crops that have been used with more or less success, among which might be mentioned oats and peas, alfalfa and clover.

Oats and Peas

In some parts of the west the climate appears to be too cold and moist for the successful production of fodder corn. In such places oats and peas give heavy yields, and have been found to make very satisfactory ensilage. This combination therefore gives promise of becoming the ensilage crop in those districts. The mixture is a very valuable one from the standpoint of the feeder, since it produces a fairly well balanced ration. To obtain the largest amount of peas that can be grown per acre and harvested with the grain binder the mixture should include one bushel of peas to two bushels of oats per acre. The varieties that have given best satisfaction are Banner oats and Golden Vine peas. Any other combination of varieties that mature about the same time can be used. In putting oats and

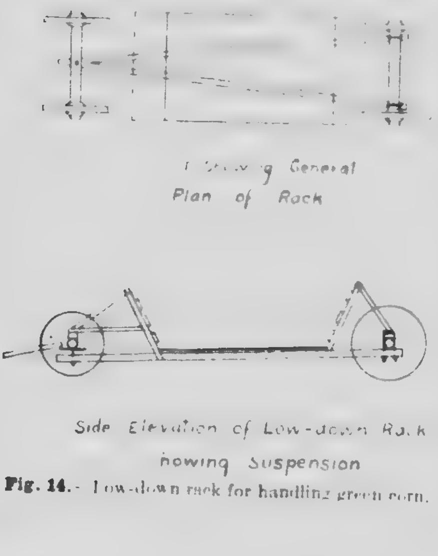
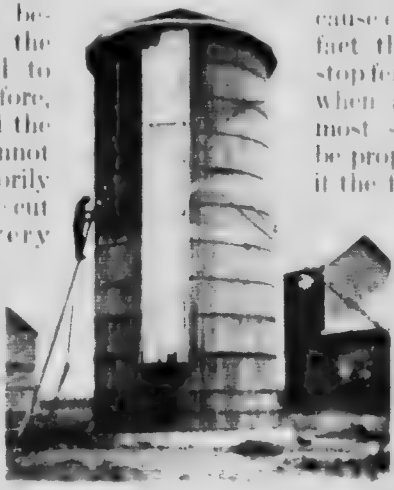


Fig. 14.- Low-down rack for handling green corn.

peas into the silo care must be taken to have them well tramped as the hollow stems carry considerable air. From the result of experiments it would appear that to obtain the largest quantity of the best quality of ensilage the crop should be cut when the oats are in the milk stage. The sheaves should be ensiled as soon after cutting as possible. To facilitate the packing the ensilage cutter should be set to cut the straw into about quarter-inch lengths.

Alfalfa

In Manitoba it is often difficult to cure the first cutting of alfalfa because of the large amount of rain in the month of June. The possibility, therefore, of preserving it in the silo demands some consideration. It is generally believed, however, that alfalfa ensilage is not equal to corn ensilage because of its liability to spoil. This is largely due to the fact that legumes do not produce sufficient acid to stop fermentation before decay has started. Therefore, when alfalfa can be cured as hay it will be found the most satisfactory method. If, for any reason it cannot be properly cured it may be ensiled fairly satisfactorily if the following precautions are taken. It should be cut up fine and the tramping must be very thorough in order to force out a large amount of the air. It might be even necessary to add some weight, such as heavy stones, on the top, in order to assist in the settling. The alfalfa should be ensiled as soon as possible after cutting, in order to avoid any drying out, since there will not usually be too much water in the plant. If it does become dry it will be necessary to add water to assist in the packing and subsequent fermentation. As, has been previously mentioned, it is usually the first cutting of alfalfa that gives trouble in curing. Much of this might be fed out before the harvesting of the corn, but in case it is necessary to fill in on top of the alfalfa it will usually be found quite safe to do so as the great depth of green corn will effectually seal up the grain, and the great weight will close up all air spaces. It will be first necessary, however, to throw out all damaged alfalfa before filling with the corn. A number of experiments on alfalfa ensilage have indicated that alfalfa makes ensilage which keeps well during the first few months, but after this time there is a tendency to decompose and take on a bad odor, thus losing considerable of its feeding value.



A silo on which the hoops were not kept tight and it required plumbing

Clover

What has been said in regard to alfalfa will apply equally to clover.

FILLING THE SILO

Harvesting

Corn for the silo may be cut either by hand or by machine. Hand cutting may be practised on farms where the area to be harvested is so small as to make the expense of purchasing a corn harvester too great to justify its use. Hand cutting may be a necessity in case the corn is down or lodged in such a manner as to prevent the use of the machine. Where the area is sufficiently large to justify its use a corn harvester should be purchased, since the grain binder is not entirely satisfactory. To produce sufficient corn for the average silo will require from fifteen to twenty-five acres of corn, and it is generally considered that twenty acres of corn will justify the purchase of a corn harvester.

In using a harvester it will be found an advantage to have the bundles made rather small. This will take more twine but the expense is more than offset by the ease of handling the bundles, in loading, and in feeding to the ensilage cutter. Three horses should be used and should cut about six acres per day. If fairly ripe corn is being harvested the machine should not get so far ahead of the haulers that the corn will dry out too much.

Hauling to the Cutter

This is ordinarily done with the common hay rack, but this is objectionable in that it is necessary to lift the green corn to a considerable height in loading, which is very hard work. A low-wheeled wagon would be preferable for this purpose. Where, however, the ordinary high-wheeled wagon must be used it is a great help to have a low down rack (such as is shown in Fig. No. 14) for hauling the corn from the field.

The rack consists of two 4x6-inch bed pieces 18 or 20 feet in length bolted together at one end to form a V. On top of these timbers is built a rack 6 feet in width. The bottom of this rack is about 8 feet long. The end boards are 4 feet high, built flaring so they do not quite touch the wheels. The apex of the V is suspended below the front axle of an ordinary farm wagon by means of a long kingbolt. The other ends are attached below the hind axle by U-shaped clevises. The materials used in its construction are 80 board feet of 4x6-inch timber, 96 feet of boards 1x12 inches, 22 feet of scantling 2x4 inches, one long kingbolt, two stirrup rods, bolts and nails.

These racks not only lessen the labor of loading the corn, but make it possible to dispense with a man upon the wagon when loading. They are also an advantage in unloading, in that the man can stand on the ground and simply draw the corn towards him and lay it upon the table of the cutter, without stooping over and raising the corn up to again throw it down.

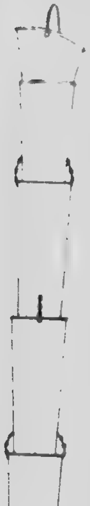


Fig. 15.
Pipe for distributing ensilage in Silo

The load should be as large as possible, especially when the haul is long. Care should be taken, however, not to over-tax the team when large racks are used, as green corn is very heavy. If corn is to be wilted and the weather is unsettled it should be stooked to protect it as much as possible from rain.

The Ensilage Machine

The corn having been hauled from the field to the silo has still to be reduced to a fine homogeneous mass so that it will pack well in the silo and will be in convenient condition for feeding. In order to do this an ensilage cutter is necessary. There are on the market several makes of ensilage cutters that will give satisfaction. The capacity of the machine to be purchased is an important consideration, and should not be overlooked. The cutter should have ample capacity to give satisfaction and do the work rapidly; a rather large machine is therefore better than one that is barely large enough. The size required depends on the rapidity with which it is desired to fill the silo and on the power at hand. It is better to get a machine large enough so that everyone will be kept busy all the time. The larger cutters are equipped with self-feeders, a labor saving device which the smaller sizes lack. For the filling of a small silo it would not be wise to purchase a large machine, nor is it advisable to overload the motor or engine used.

The Elevator

Two types of elevators are in use— the old style chain carrier, and the blower. The chain carrier requires less power but is harder to set up, and there is more litter around when it is used, especially in windy weather. The newer and more modern method of elevating the cut fodder is by the blower elevator through a continuous pipe. When sufficient power is available there is no doubt as to its superiority for elevating the material into the highest silo. The blower pipe is easily set up or removed since it is made in sections of various lengths. It should be placed as nearly perpendicular as possible so as to reduce to the minimum the friction of the cut corn upon the inside of the pipe and lessen the danger of clogging. The machine must also be run at the proper speed, as indicated by the manufacturer. A fan can only create a sufficient blast by running fast enough to force air through the pipe at the rate of nine or ten thousand feet per minute. Unless proper speed is maintained there will be no elevation of the material whatever, and the lower part of the pipe will become clogged. Hence, if the power at hand is not sufficient to maintain full speed when the cutter is fed the full capacity the rate of feeding must be cut down to the point where full speed can be maintained, as is necessary in threshing machines, etc. The feeder will very quickly become accustomed to the characteristic hum which denotes the correct speed. It is quite essential to see that full speed is attained before beginning to feed the machine, and also to stop feeding while the machine is in full motion so that the blower will have an opportunity to clean itself before shutting off the power. There should be ample vent in the silo to prevent back pressure, as the tremendous volume of air forced into the silo with the cut fodder must have some means of escape.

Power Required

The power necessary to operate the cutter will depend upon its size and whether the elevator is a chain carrier or a blower, and upon the rate of feeding. As previously intimated, it is possible to feed slowly and get along with less power than would be required with full feeding. As a rule, however, the power should be sufficient to run the cutter at full capacity, and even a little surplus is advisable. The power required for a cutter and blower, if a gasoline engine is used, is about one horse-power for each one inch length in the cutting cylinder, i.e., a fifteen-inch cutter will require a fifteen horse-power engine, an eighteen-inch an eighteen horse-power, and so on. If a steam engine is employed the power should be at least two-thirds of that indicated for the gasoline engine.

Length to Cut

Most ensilage cutters are so constructed that the corn may be cut in lengths from one-quarter to one inch when four knives are used, or twice these lengths when only two knives are in the machine. The length of cutting practised differs somewhat with different farmers. Care should be taken in this respect, however, for the length of cut has much to do with the quality of the ensilage. Experience has demonstrated that the half-inch cut, or even shorter, gives most satisfactory results. The corn will pack better in the silo the finer it is cut, thus excluding the air, and at the same time increasing the capacity of the silo to a considerable extent. Cattle will also eat the coarser parts cleaner if cut fine. On the other hand the larger the pieces the more rapidly can the corn be run through the cutter, and with the smaller finer varieties it is quite possible to secure good results by cutting into three-quarter or one-inch lengths.

Distribution and Packing

The distribution of the cut corn after it has been elevated or blown into the silo is a matter which should have proper attention at the time of filling. If the cut material is allowed to drop all in one place and then have no further attention the constant falling of the material in one place will tend to make that portion solid while the outside will not be so. The pieces of ears and heavier portions will roll to the outside, giving an unequal distribution and uneven settling will result. Ordinarily there are one or more men in the silo to distribute and tramp the material. The most successful practice is to keep the material higher at the sides than at the centre and do all the tramping at and close to the sides where the friction of the walls tends to prevent as rapid settling as takes place at the centre. In modern deep silos the weight of the ensilage accomplishes more than would any amount of tramping. All that is necessary is to see that the cut material is evenly distributed, and to assist the settling by some tramping at the sides.

Various contrivances have been used for distributing the ensilage. The one which has proven the most satisfactory is a metal pipe similar to the one in which the cut corn is elevated and put together loosely in sections which can be readily detached as the ensilage rises in the silo. The corn from the blower passes down this pipe into the silo, and being loosely put together it can be swung by the hand so that the material can be placed anywhere in the silo. (See Fig. No. 15.)

With this contrivance no work with a fork is necessary, and one man can do the work of two or three and do it more easily. The silo is also much pleasanter to work in when it is used since there is very little loose material flying about. Another advantage is a lessening of the danger of being struck by some foreign object which might pass up the blower pipe. The cost of this piece of equipment would soon be recovered in the saving of labor effected.

Addition of Water

The practice of applying water to the cut fodder in the silo is one that has obtained to a considerable degree in the States to the south and in eastern Canada. Under western conditions where corn is not likely to become any too ripe, the addition of water is unnecessary except in cases where the corn goes into the silo in a rather dry condition, which may be caused by a frost before cutting or by allowing the crop to stand too long after cutting before hauling to the silo. However, the claim is made that even quite dry fodder has been successfully ensiled by adding plenty of water. The use of water assists in packing, and unless such dried material is well packed, the ensilage will "fire-fang" or deteriorate through the growth of mold. The water may be added by running directly into the silo by means of a hose, or by running through the blower. It is claimed that the water is more thoroughly mixed with the corn when the stream is fed into the blower.

According to some experiments, it seems to be good practice, no matter what the condition of the corn is, to wet down the material thoroughly at the top of the silo, a few days after the filling is completed. Water is added at the rate of about ten pounds per square foot of surface, repeating the process about ten days afterwards. By this method a sticky, almost impervious, layer of rotten ensilage a couple of inches thick will form on the top, which prevents evaporation of water from the corn below, and will preserve all but a few inches at the top.

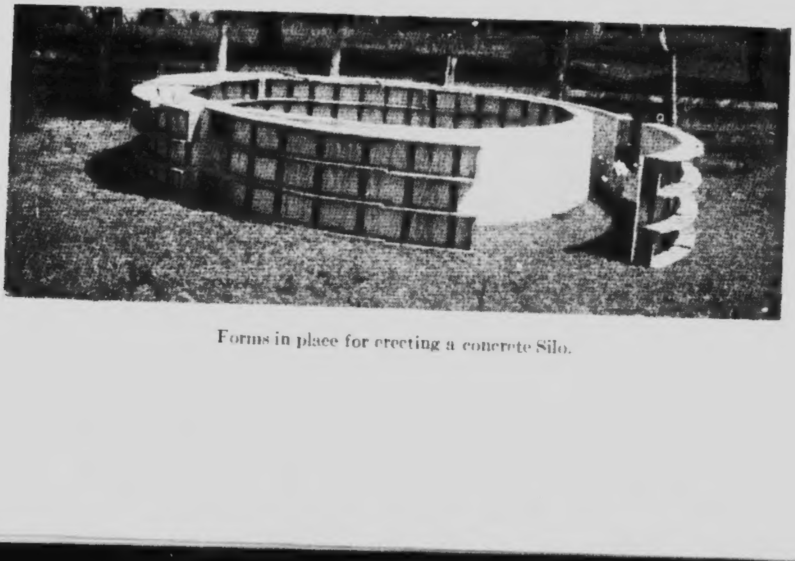
Danger from Carbonic Acid Poisoning in Silos

Very shortly after the first corn is put in the silo the heating process begins, with the evolution of carbonic acid gas. If the silo is shut up tight the gas will gradually accumulate directly above the fodder since it is heavier than air and does not mix with it in a still atmosphere. If a man goes down into this atmosphere there is danger of asphyxiation, as is the case under similar conditions in a deep well. Poisoning cases have occurred in this way where the filling has been interrupted for a day or two and men have gone into the silo to tramp down the cut corn. However, if the doors above the ensiled mass are left open when the filling is stopped and the silo thus ventilated, the gas will diffuse through the air. Carbonic acid possesses neither odor, taste, or color, hence it cannot be directly observed, but may be readily detected by lowering a lighted candle or lantern into the silo, when, if there is an accumulation of gas, the light will go out. In this case the feed doors should be opened and the air disturbed in some way before entering. Where the blower is used the blowing in of a little corn from the first load should be ample stirring. After the ensilage is made and the temperature in the silo has gone down considerably there is no danger to be feared from this source.

Covering the Ensiled Fodder

Many devices have been tried for covering the ensiled fodder in order to preserve the upper portion. The original method was to put boards on top of the fodder and weight them heavily by means of a foot layer of dirt or sand or with stone. Later lighter material, as sawdust, straw, and hay was substituted. Building paper was often placed over the fodder. At the present time a common practice is to run green corn stalks, from which the ears have been removed, through the machine after the fodder is all in. Mention has already been made of the efficacy of adding water to the surface. Very good results have resulted from sowing a liberal seeding of oats on top before wetting. The heat generated by the fermenting mass will cause the oats to sprout quickly and form a dense sod which serves to shut off the air from the ensilage beneath, and only a very shallow layer spoils.

None of these methods can perfectly preserve the upper layer of ensilage, and there will always be some loss. The only way in which all of the ensilage can be preserved intact is by beginning to feed it within a few days after filling is completed. This method possesses considerable merit in that it allows of the supplementing of scant fall pastures and is thus particularly good practice for dairymen. When this method is adopted the ensiling system is brought to perfection provided the silo is so constructed as to admit of no unnecessary losses of nutrients. Under these conditions there is a very considerable saving over ensilage made in poorly constructed silos or over field-cured shocked fodder corn.



Forms in place for erecting a concrete Silo.

MANITOBA AGRICULTURAL COLLEGE

(EXTENSION SERVICE)

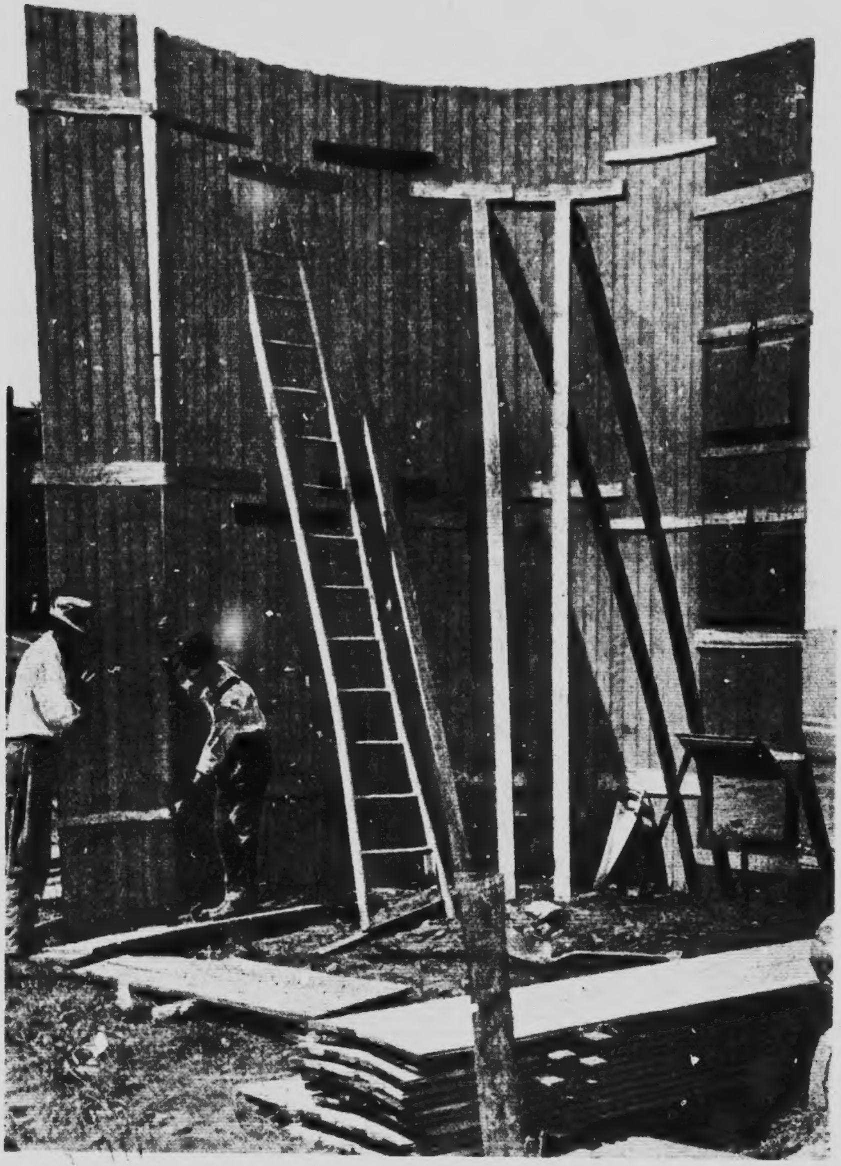
Any of the following Bulletins or Circulars may be obtained free on request from the Extension Department:

BULLETINS

1—Horses.
2—Twelve Noxious Weeds.
3—Care of Milk and Cream.
4—Protection of Farm Buildings from Lightning.
5—The Farm Garden.
6—Farm Poultry in Manitoba.
7—Hog Raising in Manitoba.
8—Cow Testing.
9—Repairing Farm Equipment and Roads.
10—Plans for Farm Buildings.
11—Canning and Preserving.
12—The Farm Flock.
13—Barn Ventilation.
14—Care of Cream for Creameries.
15—Boys' and Girls' Clubs.
16—Hay and Pasture Crops in Manitoba.
17—Silo Construction and Ensilage Production.
18—Bee-Keeping in Manitoba.
20—College Extension Service.

CIRCULARS

1—The Farmers' Beef Ring.
2—Some Facts About Sheep.
3—Manitoba's Hog Market.
4—Beef Cattle Situation.
5—A Few Dairy Facts.
6—A Plea for Bird Houses.
7—Our Friends, the Birds.
8—Hints on Home Nursing.
9—Practical Hints on Poultry.
10—Meat and Its Substitutes.
11—What Every Girl Should Know.
12—Poison Ivy and Other Poisonous Plants.
13—Cream for Creameries.
14—Method in Dressmaking.
15—Fattening Chickens for Market.
16—Pork Making on the Farm.
17—Servants in the House.
18—Alfalfa in Manitoba.
19—Fodder Corn in Manitoba.
20—Alfalfa Inoculation.
21—Barley Growing.
22—Notes on Growing Trees, Shrubs, etc.
23—Improving the Farm Egg.
24—Growing Plums in Manitoba.
25—Growing Cherries in Manitoba.
26—Control of Insect Pests.
27—Pruning Trees for a Cold Climate.
28—[illegible] Mixtures
29—[illegible] Pests and Cutworms.



Showing method of erecting a stave silo without the aid of scaffolding. Note the sections, piled on the ground, ready to use.